Detection of Voids in Additive Manufacturing Using X-rays

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1. Introduction

In x-ray computed tomography, multiple angular projections are obtained to reconstruct the object in 3D space to look for defects. The process can be time-consuming.

The aim is to investigate if defect detection can be done using a single angular projection. An additive manufactured test sample was created with voids to see if they can be detected.

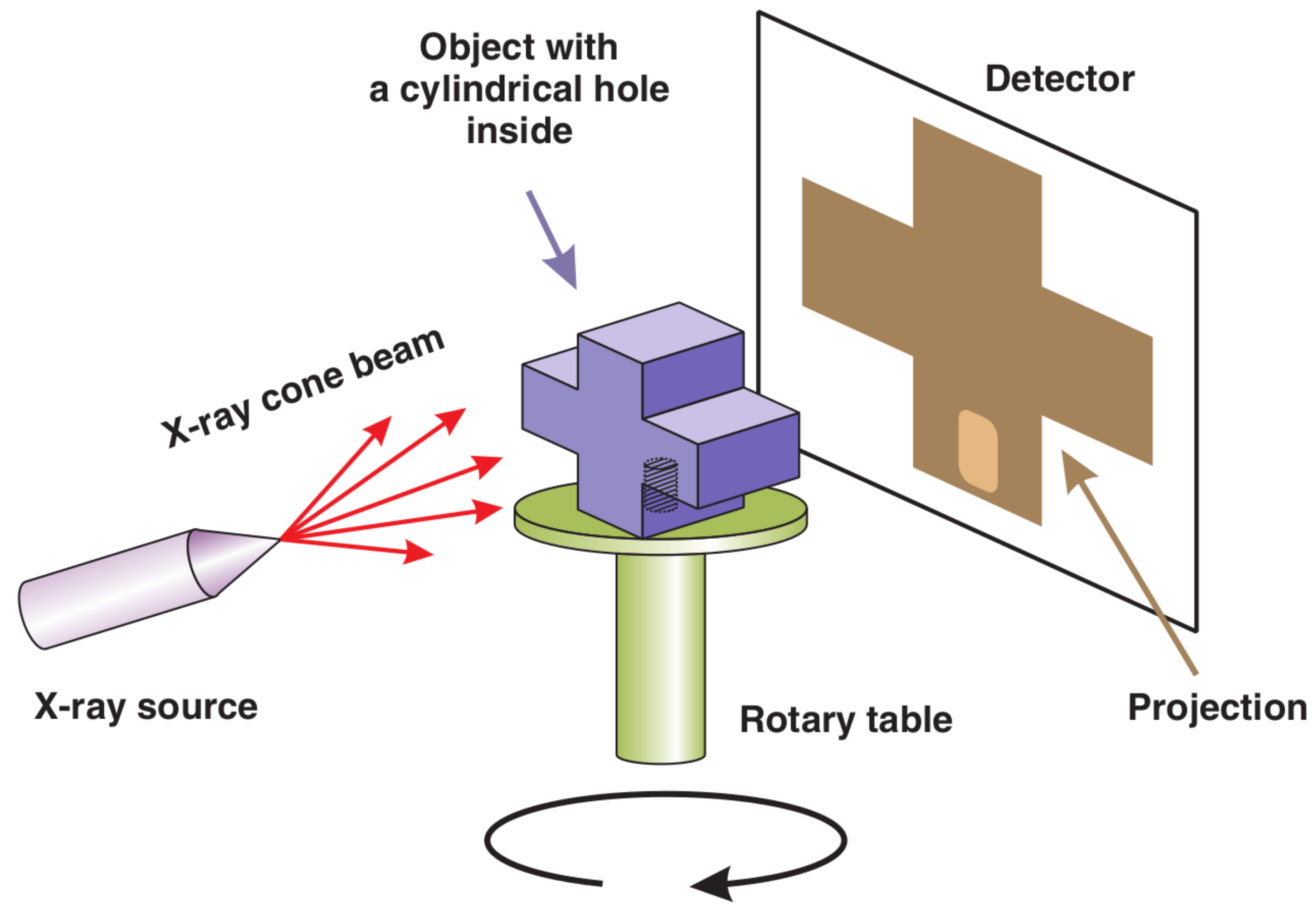

Figure 1: X-ray computed tomography
Source: Warnett et al. (2016)

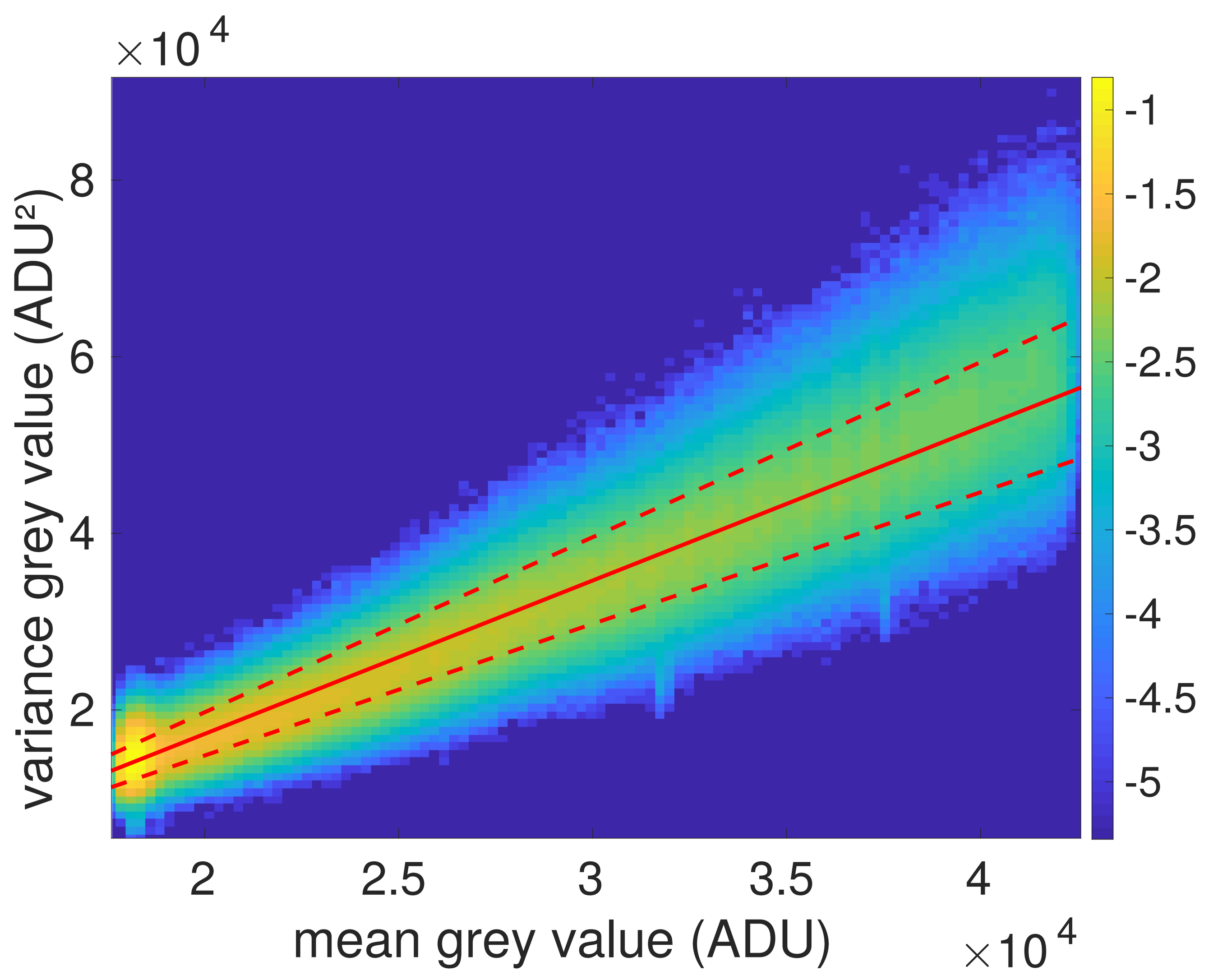

Figure 2: Log frequency density histogram of the mean and variance grey values from projections of the test sample.

2. Compound Poisson

The projection was modelled using a compound Poisson distribution because x-ray photon arrivals are a Poisson process. This result in a linear relationship between the mean and variance.

A gamma distributed generalised linear model was fitted and used for variance prediction.

3. Inference

A simulation of the projection was compared with the obtained projection under the face of uncertainty.

$$\frac{\text{projection}_{x,y} - \text{simulation}_{x,y}}{\sqrt{\mathbb{V}\text{ar}\left[\text{projection}_{x,y}\right]}} \sim \text{N}\left(\widehat{\mu}_{0,x,y}, \widehat{\sigma}^2_{0,x,y}\right)$$

To overcome the imperfections of the simulation, the empirical null filter was used to cater for model misspecification so that sensible inference was achieved.

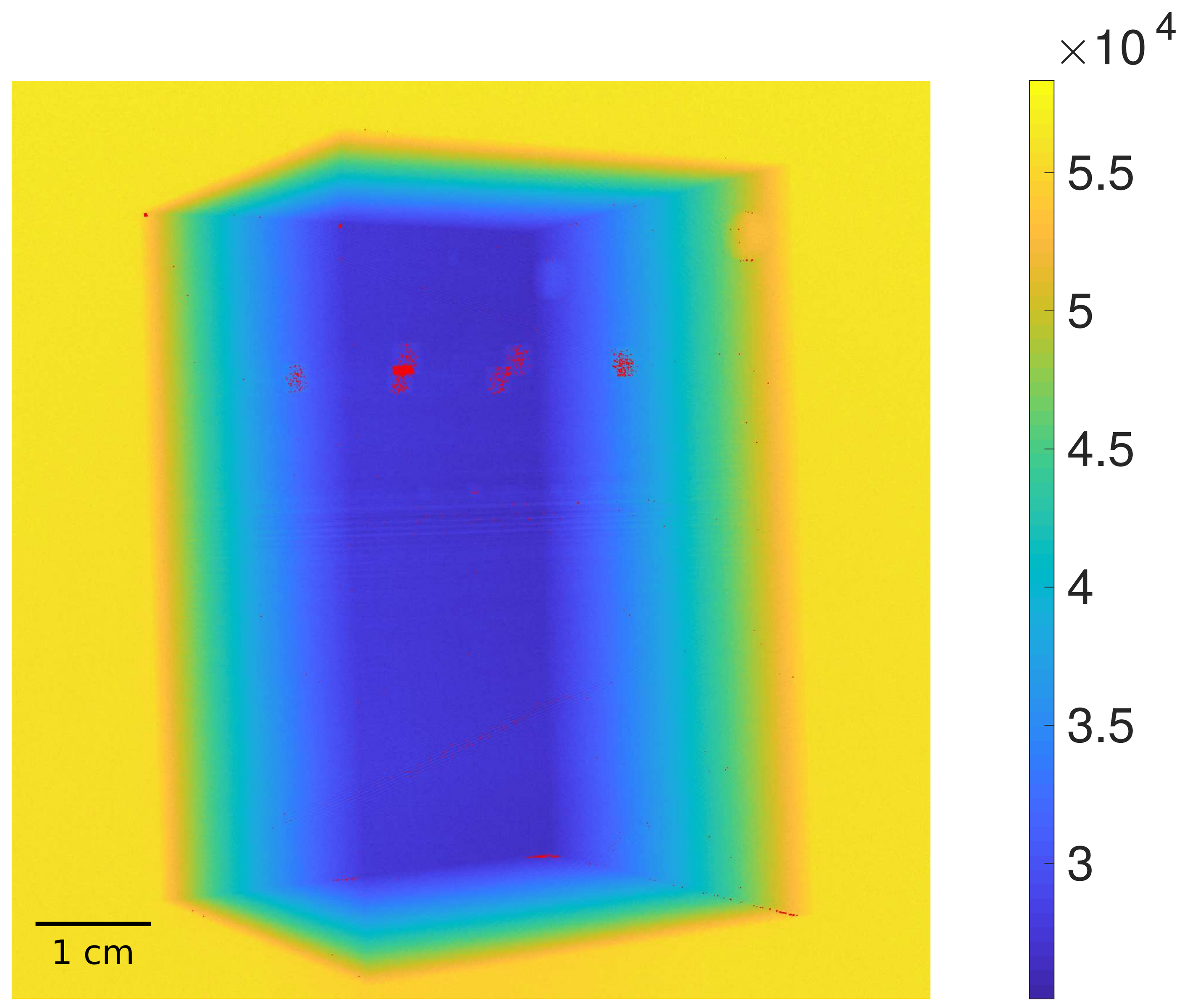

Figure 3: X-ray projection of the test sample, highlighted in red are positive pixels at the 5% FDR level.

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